GRANITE SPRING G-E-M RESOURCES AREA (GRA NO. NV-09) TECHNICAL REPORT (WSA NV 040-086)

Contract YA-554-RFP2-1054

Prepared By

Great Basin GEM Joint Venture
251 Ralston Street
Reno, Nevada 89503

For

Bureau of Land Management
Denver Service Center
Building 50, Mailroom
Denver Federal Center
Denver, Colorado 80225

Final Report

April 29, 1983

TABLE OF CONTENTS

Table of Contents cont.

Table of Contents cont.

Table of Contents cont.

Page

LIST OF ILLUSTRATIONS

EXECUTIVE SUMMARY

The Granite Spring Geology-Energy-Minerals (GEM) Resource Area (GRA) includes the following Wilderness Study Area (WSA): NV 040-086. The Granite Spring GRA is located in eastern White Pine County, Nevada adjacent to Utah in the Snake Range just north of Mount Moriah and the Humbolt National Forest.

Geologically the GRA contains mostly 500 to 600 million year old carbonate rocks flanked by alluvial fans to the east, north and west. These old rocks are involved in complicated overthrust relationships with one another.

The known metallic mineral resources in the GRA include the White Cloud district which produced minor amounts of lead, zinc and silver; the Silver Peak mine producer of minor lead and silver; and one tungsten prospect and other unknown prospects. All these deposits or occurrences are in the carbonate units in the GRA, but none are within the WSA. There are abundant reserves of marble within the GRA and the WSA and a limited amount of production has taken place. Lead, zinc and silver are the strategic and critical minerals which have been produced in the GRA but outside the WSA. Tungsten, also a strategic and critical mineral occurs in the GRA, but outside the WSA.

There are no patented claims in the GRA. At least 50 unpatented placer claims cover marble both in the GRA and the WSA. A few lode claims are found in the White Cloud district and south of the WSA on Forest Service land.

The flanks of the Snake Range where alluvium predominates has been leased for oil and gas. There are no geothermal leases in the GRA.

The WSA has a low potential for metallic mineral resources with a very low to low confidence level, as it possesses similar geology to known mineral deposits and occurrences in other parts of the GRA. The WSA has a high favorability with a high confidence level for marble for building stone. All carbonate units in the WSA have a moderate favorability with a moderate confidence level for cement or lime. The alluvium in the WSA has a moderate favorability with a moderate confidence level for sand and gravel resources.

Uranium has a low favorability with a very low to low confidence level, and thorium has a very low favorability with a very low confidence level. The majority of the WSA has a low favorability for oil and gas with a very low confidence level, and a very low favorability for geothermal with a very low confidence level.

Recommendations for further work include more detailed mapping and further evaluation of some claims outside the southern boundary of

the WSA to see if they could lead to any refinement of the mineral potential within the WSA.

I. INTRODUCTION

The Granite Spring G-E-M Resources Area (GRA No. NV-09) contains approximately 220,000 acres (880 sq km) and includes the following Wilderness Study Area (WSA):

WSA Name	WSA Number
Granite Springs	NV-040-086

The GRA is located in Nevada within the Bureau of Land Management's (BLM) Schell Resource Area, Ely district. Figure 1 is an index map showing the location of the GRA. The area encompassed is near 39°25' north latitude, 114°15' west longitude and includes the following townships:

T 20 N, R 68-70 E	T 18 N, R 68-70 E
T 19 N, R 68-70 E	T 17 N, R 68-70 E

The nearest town is Baker, Nevada which is located approximately 20 miles south of the southern border of the GRA at the intersection of State Route 73 and State Route 74. Access to the area is via improved dirt roads to the southwest, north and northeast. These roads branch off of U. S. Highway 50 to the south. Access within the area is via a few unimproved dirt roads and jeep trails, most peripheral to the WSA.

Figure 2 outlines the boundaries of the GRA and the accompanying WSAs on a topographic base at a scale of 1:250,000.

Figure 3 is a geologic map of the GRA and vicinity, also at 1:250,000. At the end of the report, following the Land Classification Maps, is a geologic time scale showing the various geologic eras, periods and epochs by name as they are used in the text, with the corresponding age in years. This is so that the reader who is not familiar with geologic time subdivisions will have a comprehensive reference for the geochronology of events.

This GRA Report is one of fifty-five reports on the Geology-Energy-Minerals potential of Wilderness Study Areas in the Basin and Range Province, prepared for the Bureau of Land Management by the Great Basin GEM Joint Venture.

The principals of the Venture are Arthur Baker III, G. Martin Booth III and Dennis P. Bryan. The study is principally a literature search supplemented by information provided by claim owners, other individuals with knowledge of some areas, and both specific and general experience of the authors. Brief field verification work was conducted on approximately 25 percent of the WSAs covered by the study.

This WSA was not field checked.

One original copy of background data specifically applicable to this GEM Resource Area Report has been provided to the BLM as the GRA File. In the GRA File are items such as letters from or notes on telephone conversations with claim owners in the GRA or the WSA, plots of areas of Land Classification for Mineral Resources on maps at larger scale than those that accompany this report if such were made, original compilations of mining claim distribution, any copies of journal articles or other documents that were acquired during the research, and other notes as are deemed applicable by the authors.

As a part of the contract that resulted in this report, a background document was also written: Geological Environments of Energy and Mineral Resources. A copy of this document is included in the GRA File to this GRA report. There are some geological environments that are known to be favorable for certain kinds of mineral deposits, while other environments are known to be much less favorable. In many instances conclusions as to the favorability of areas for the accumulation of mineral resources, drawn in these GRA Reports, have been influenced by the geology of the areas, regardless of whether occurrences of valuable minerals are known to be present. This document is provided to give the reader some understanding of at least the most important aspects of geological environments that were in the minds of the authors when they wrote these reports.

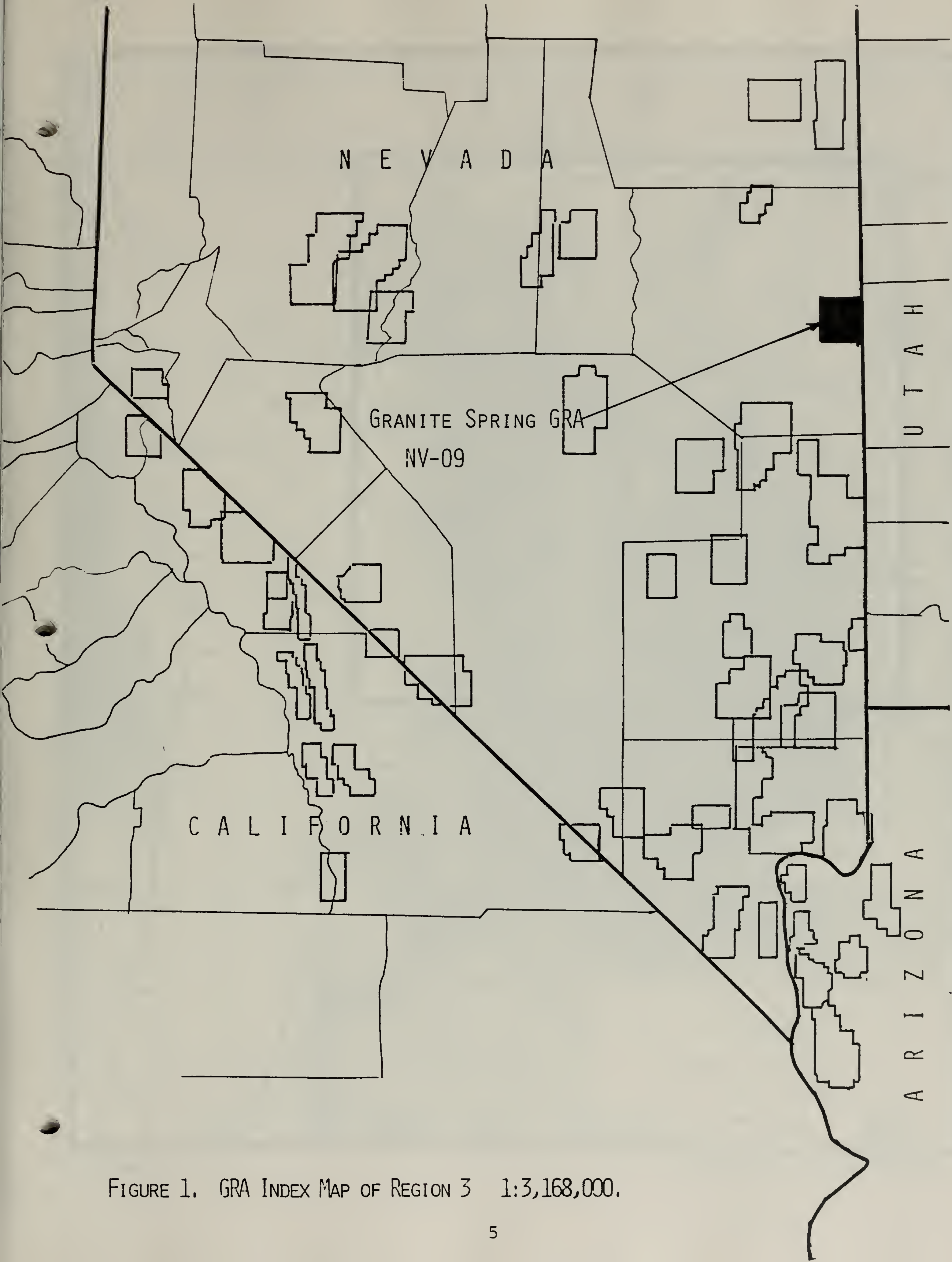
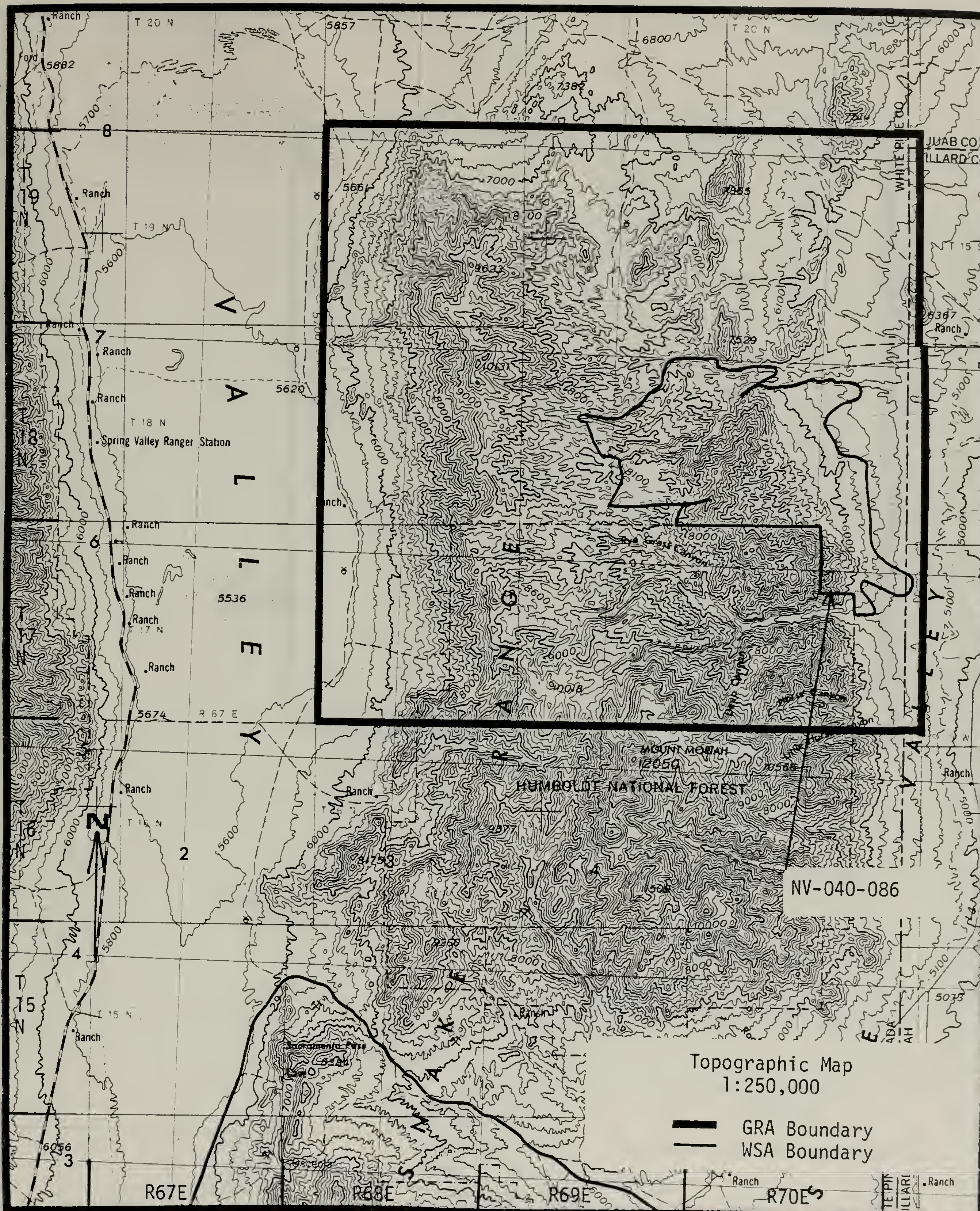


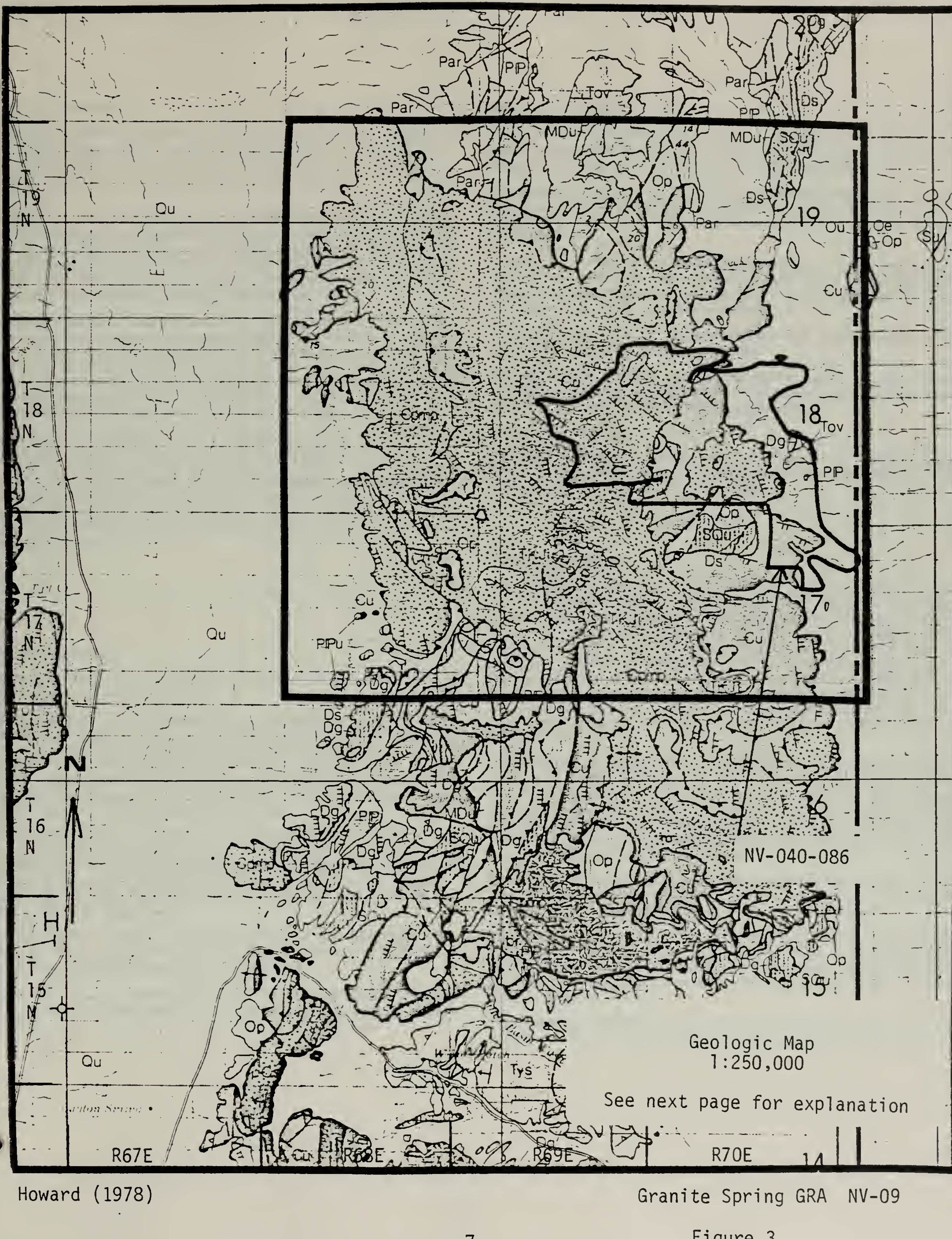
Figure 1. GRA Index Map of Region 3 1:3,168,000.



Ely Sheet

Granite Spring GRA NV-09

Figure 2



Howard (1978)

Granite Spring GRA NV-09

Figure 3

EXPLANATION

Cenozoic Sediments

Quaternary, Undifferentiated (Qu): *Includes all sedimentary rocks and surface exposures of recent playa deposits, dune sands, lake beds, shoreline deposits and younger as well as certain older exposures of gravels and other alluvium associated with pediments and mountain streams.*

Tertiary Younger Sediments (Tys): *Sedimenetary rocks of Miocene and Pliocene age including older lake beds of the Muddy Creek Formation and Panaca Formation in Lincoln and Clark Counties; the Muddy Creek Formation in Southwestern Utah; pre-Quaternary sediments in the White River Valley; and sediments associated with ash-flow tuffs near Antelope Summit in White Pine County.*

Tertiary Sediments, Undifferentiated (Tsu): *Primarily Miocene and upper Oligocene deposits including tuffaceous sediments interbedded with ash flow tuffs, the Horse Camp Formation and various unidentified tuffs, tuffaceous shales and diatomites in Nye County; intravolcanic tuffaceous and clastic sedimentary rocks in Lincoln and Nye Counties; and conglomerates and limestones of uncertain age in the Conger-Confusion Ranges and the Cricket Mountains of Utah.*

Tertiary Older Sediments (Tos): *Includes the Sheep Pass Formation in Lincoln and Nye Counties; the Gilmore Gulch Formation in Nye County; unnamed lacustrine limestones in southern Lincoln County; older gravels, conglomerates, tuffaceous and clastic sedimentary rocks, limestones, cherts, claystones, silts, carbonaceous shales and oil shales in Elko County; and older limestones of the Illipah area and the Kinsey Canyon Formation of the Schell Creek and Grant Ranges in White Pine County.*

Cenozoic Volcanics

Quaternary Basalt (Qb): *Basalt, andesite and latite of Quaternary or late Tertiary age in Nye County.*

Tertiary Basalt (Tb): *Intermediate and basaltic lavas including the Fortification Basalt Member of the Muddy Creek Formation in Clark County; basalt flows, basaltic cinder, tuff and lava cones which are included in parts of the Banbury Formation and latite flows in Elko County; basalt flows and dikes in Lincoln County; andesite and basalt flows of various ages in North Central Nevada; and basalt and basaltic andesite flows in Southwestern Utah.*

Tertiary Volcanics, Undifferentiated (Tvu): *Early to late Tertiary volcanic rocks ranging in composition from silicic to intermediate; primarily rhyolites, dacites, quartz latite flows, ignimbrites and pyroclastics of widespread occurrence. These rocks are listed under various subdivisions in Elko, Lincoln, and Nye Counties; North Central Nevada and Southwestern Utah.*

Tertiary Older Volcanics (Tov): *Pre-Miocene volcanic rocks lithologically similar to Tertiary Volcanics, Undifferentiated (Tvu). Listed under various subdivisions in Nye County.*

Intrusives (TKJi): *Occurred from mid-Jurassic through late Tertiary. Widespread intrusions ranging in composition from granitic through gabbroic and in texture from holocrystalline to porphyritic.*

Mesozoic Sediments

Tertiary-Cretaceous Sediments (TKsu): *Continental sediments consisting of fanglomerates, clastics, tuffs and limestones. Includes the Gale Hills Formation and the Overton Fanglomerate.*

Cretaceous Sediments (Ks): *Chiefly non-marine siltstone, shale, conglomerate and limestone. Includes lower Gale Hills Formation, Thumb Formation, Baseline Sandstone, Willow Tank and Newark Canyon Formations.*

Jurassic (Ju): *Eolian cross-bedded sandstone in Utah, volcanically derived sediments, ash flows and basic lava flows in northern Elko County. Includes Navajo Sandstone, Aztec Sandstone, Frenchie Creek Formation and Bayer Ranch Formation.*

Jurassic-Triassic (JTRu): *Includes Nugget and Aztec Sandstones and Chinle Formation of southern Nevada.*

Triassic (TRu): *Shallow marine sedimentary rocks including Chinle, Shinarump, Thaynes and Moenkopi Formations in the west and continental to shallow marine sediments in the east.*

Mesozoic Volcanics

Tertiary-Cretaceous Volcanics (TKvu): *Occur in Lincoln County where it covers wide areas of the Clover, Del Mar, Wilson Creek, White Rock and Mahogany Mountains.*

Paleozoic Sediments

Permian, Undifferentiated (Pu): *Shallow marine intertidal and continental sediments. Includes Gerster Formation, Plympton Formation, Kaibab Limestone, Pequop Formation, Coconino Sandstone, Arcturus Formation, Rieptown Formation, Rib Hill Sandstone, Riepe Springs Formation, Carbon Ridge Formation and Loray Limestone. With the exception of parts of White Pine County, local symbols are used to identify all Permian outcrops. In White Pine County, local symbols are used except for the Park City Group which is grouped with the Arcturus and Rib Hill Sandstones (*Par*). To avoid confusion, non-standard symbol used for Permian in Utah has been replaced with the standard "*P*".*

Pennsylvanian-Permian (PPu): *Marine sandstone and limestone (dolomatized in places). Includes Rib Hill Sandstone, Riepe Spring Limestone and Ferguson Mountain Formation in southern Elko County; Strathearn Formation, Buckskin Mountain Formation, Beacon Flat Formation and Carlin Canyon Formation in Eureka County; Pablo Formation in Nye County; and Oquirrh Formation or group in Utah. Local symbols are used where possible.*

Pennsylvanian, Undifferentiated (Pu): *Includes Ely Limestone, Moleen and Tomera Formations. To avoid confusion, the non-standard symbol used for Pennsylvanian in Utah has been replaced by "*P*".*

Mississippian Upper (Mu): *Includes Diamond Peak and Bird Spring Formations, Callville Limestone, Scotty Wash Formation, Ochre Mountain Limestone and Manning Canyon Shale in parts of Clark County. Chainman Shale is combined with Diamond Peak Formation in some parts of Utah.*

Mississippian, Chainman Shale (Mc): *Includes Mountain City Formation in Elko County and Eleana Formation in Nye County.*

Mississippian, Lower (Ml): *Includes Monte Cristo and Rogers Spring Limestones in Clark County; Joana, Mercury and Bristol Pass Limestones in Lincoln County; and Joana Limestone elsewhere.*

Mississippian-Devonian, Undfiferentiated (MDu): *Includes Rogers Spring Limestone and Muddy Peak Limestone in parts of Clark County; Joana Limestone and Pilot Shale in Elko County; Pilot Shale, Joana Limestone, Chainman Shale and Diamond Peak Formation in Eureka and White Pine Counties.*

Mississippian-Devonian, Pilot Shale (MDp): *Shown in combination with other Mississippian Formations in Clark, Elko, parts of Lincoln, Eureka and White Pine Counties.*

Devonian-Cambrian, Undifferentiated (DSOЄu): *Undivided limestone and dolomite occurring in Lincoln County.*

Devonian-Ordovician, Undifferentiated (DSOu): *Dolomites in Elko and Nye Counties.*

Devonian, Upper (Du): *Primarily Devils Gate and Guilmette Formations. Also includes Sevy and Simonson dolomites in parts of White Pine County. Contains Guilmette, Devils Gate, Simonson and Sevy in Elko County under the heading of* Dgd. *Local symbols used where possible.*

Simonson Dolomite (Dsi): *Alternating light to dark gray fine to coarse grained dolomite. Included with other Silurian and Devonian sediments in North Central Nevada and parts of Utah. Grouped with Sevy Dolomite in parts of Clark, Elko, Eureka, Nye, and White Pine Counties.*

Sevy Dolomite (Dse): *Very light colored, dense, distinctly bedded unfossiliferous dolomite. Combined with other Devonian and Silurian sediments in parts of North Central Nevada and Utah and with the Simonson Dolomite in parts of Clark, Elko, Eureka, Nye and White Pine Counties.*

Sevy and Simonson Dolomites, combined (Dun): *Also includes the Sultan and Muddy Peak Limestones in Clark County; Nevada Formation in Elko County; Devils Gate Formation in Eureka County; Nevada Formation, Woodpecker Limestone, Oxyolk Canyon Sandstone and Rabbit Hill Formation in Nye County; Nevada Formation and Devils Gate Formation in Eureka County and the Nevada Formation in White Pine County. Local symbols are used where possible.*

Devonian, Western Facies (Dw): *A portion of the western allochthonous assemblage. Includes Woodruff Formation and Slavern Chert in Eureka County and silicious siltstone in the Cockalorum Wash area of Nye County.*

Silurian, Undifferentiated (Su): *Includes Lone Mountain and Laketown Dolomites throughout the mapping area, the Elder Sandstone and Fourmile Canyon formation in Eureka County, and the Roberts Mountain formation in Nye County. In White Pine County, the Silurian deposits are grouped with the upper Ordovician sediments under the heading of Silurian-Ordovician, Undifferentiated* (SOu).

Upper Ordovician, Undifferentiated (Oupu): *Includes Ely Springs and Fish Haven Dolomites and the Hanson Creek Formation. Local symbols are used where possible. Listed as Ordovician, Undifferentiated* (Ou) *in parts of North Central Nevada. In Clark County, Ely Springs Dolomite has been divided from the rest of* Oep *by the author. The Eureka Quartzite and Pogonip Group are grouped with Silurian sediments under the heading Silurian-Ordovician, Undifferentiated* (SOu) *in Elko County.*

Ordovician, Eureka Quartzite (Oe): *Light colored vitreous quartzite and hard sandstone. Also includes the Swan Peak Quartzite in parts of Utah. In Clark County, the Eureka Quartzite has been separated from* Oep *by the author. In parts of North Central Nevada, the Eureka Quartzite has been grouped with other Ordovician sediments under the heading of* Ou. *In White Pine County, the Eureka Quartzite has been grouped with the Pogonip Group under the heading of*

Ordovician, Pogonip Group (Op): *Limestone, silty limestone, shale and interformational conglomerates. In Clark County, the Pogonip Group has been separated from* Oep *by the author. Includes the Garden City Limestone in parts of Utah. In White Pine County, the Pogonip Group is grouped the Eureka Quartzite under the heading of* Ol.

Ordovician, Undifferentiated (Ou): *Includes the Pogonip Group, Ely Springs Dolomite, Eureka Quartzite and Comus Formation in North Central Nevada.*

Ordovician, Vinini Formation (Ovi): *Part of the western allochthonous assemblage. Includes Valmi Formation in parts of North Central Nevada. Local symbols are used where possible.*

Cambrian-Ordovician, Undifferentiated (OЄu): *Occurs in Elko, Eureka, Nye and White Pine Counties as shale and limestone and is usually so identified when metamorphosed to phyllite. Includes the Tennessee Mountain Formation in Elko County, Board Canyon, Sequence in North Central Nevada, Windfall Formation in Nye County and the lower Ordovician and post-Dunderberg Shale in the Schell Creek Range of White Pine County. In some parts of Nye County,* OЄu *is metamorphosed to slate and marble instead of phyllite.*

Cambrian, Upper and Middle (Єu): *Primarily limestones, dolomites, shales and quartzites. Includes Edgemont and Peak Limestones in Elko County; Highland Peak formation, Patterson Pass Shale, Pole Canyon Limestone, Chisholm Shale and Lyndon Limestone member of the Chisholm Shale in Lincoln County; Harmony Formation, Preble Formation, Pioche Shale, Eldorado Dolomitee, Geddes Limestone, Secret Canyon, Hamberg, Dole and Dunderberg Shales, Windfall Formation, and Scott Canyon Formation in North Central Nevada; Windfall Formation, Dunderberg Shale, Tybo Shale and Lincoln Park Formation in Nye County; Notch Peak Formation, Dunderberg Shale, Orr Formation, Weeks Formation, Marjum Formation, Wheeler Shale, Swasey Formation, Whirlwind Formation, Dome Limestone, Howell Formation and Tatow Formation in Utah; and Corset Spring Shale, Notch Peak Limestone, Dunderberg Shale and Windfall Limestone in White Pine County. Metamorphosed to schist in Elko County.*

Cambrian, Lower (Єpmp): *Primarily Prospect Mountain Dolomite and Pioche Shale. Also includes Tapeats Sandstone, Wood Canyon Formation, Lyndon Limestone, Chisholm Shale and Carrera Formation in Clark County; Sterling Quartzite and Wood Canyon Formation in parts of Lincoln County; Busby Quartzite in the Gold Hill area of Utah and the Stella Lake Quartzite in White Pine County.*

Precambrian

Precambrian Sediments (pЄs): *Includes the Johnnie Formation, Sterling Quartzite and some metamorphics in Clark County; Johnnie Formation and lower units of Prospect Mountain Quartzite in Lincoln County; McCoy Creek Group in Elko County; and the McCoy Creek Group excluding the Stella Lake Quartzite in White Pine County.*

Precambrian Intrusives (pЄi): *Includes the Gold Butte Granite in Clark County and other undifferentiated igneous and metamorphic rocks, primarily granites and pegmatites.*

II. GEOLOGY

The Granite Spring GRA lies within the Basin and Range province in east-central White Pine County, Nevada. The study area includes the northern quarter of the north-south-trending Snake Range.

The northern Snake Range consists primarily of lower plate Cambrian sediments in the central portion surrounded by upper plate thrust sheets of younger Paleozoic rocks (see Figure 3). Cretaceous-Tertiary intrusives north of Mt. Moriah have locally deformed and metamorphosed their host rocks. Early Tertiary volcanic rocks crop out in the northeast corner of the WSA.

A large Basin and Range type normal fault bounds the eastern flank of the range. Other normal faults in the study area may be Basin and Range or related to earlier tectonic activity during the Cretaceous-early Tertiary orogeny.

Most of the following geologic description is taken from the White Pine County Geologic report by Hose and Blake (1976), but others as noted have also been used.

1. PHYSIOGRAPHY

The Granite Spring GRA lies within the Basin and Range province in east-central White Pine County, Nevada, adjacent to the Nevada-Utah state border. WSA 040-086 contains a portion on the eastern flank of the north-south-trending Snake Range.

The study area includes the northern quarter of the Snake Range which is composed of Paleozoic marine sediments that have been complexly thrusted. In the southern part of the GRA, Late Cretaceous(?) (Lee and others, 1970) quartz monzonite bodies have been intruded. Tertiary volcanics crop out in the very northeastern part of the WSA.

The topography of the east and west flanks is rugged with a basin in between that drains eastward into Snake Valley. Relief in the WSA ranges from a little over 9,000 feet in the mountains to near 5,000 in Snake Valley. The west flank of the range discharges into Spring Valley which is an internal drainage.

2. ROCK UNITS

The oldest rock units in the area have been mapped by Hose and Blake (1976) as undivided Lower Cambrian marine sediments that include the Stella Lake and Prospect Mountain Quartzites and the Pioche Shale. Middle Cambrian sediments composed of limestone with some shale were next deposited. The Corset

Spring Shale and Notch Peak limestone were deposited next during the Upper Cambrian.

The lower Ordovician Pogonip Group, which consists mainly of platy to thin-bedded gray detrital limestone, overlies the Notch Peak limestone and in turn, is overlain by the Eureka Quartzite.

The deposited next rock unit is an Ordovician-Silurian sequence of carbonate rocks that includes the Fish Haven, Ely Springs, Hanson Creek, Laketown and Lone Mountain Dolomites.

The Devonian Sevy and Simonson Dolomites are the next youngest formations. These units are overlain by the Devonian Guilmette Formation which contains evenbedded, dark-gray to grayish-black Limestone that weathers olive gray to medium light gray.

The Devonian-Mississippian Pilot Shale, Joana Limestone, and Chainman Shale were deposited next. The Pennsylvanian-Permian Ely Limestone overlies the Chainman Shale. The Arcturus Formation consisting chiefly of limestone and the Rib Hill Sandstone were deposited during the Permian.

Late Cretaceous-Early Tertiary quartz-monzonite intrusive bodies were emplaced in the area north of Mt. Moriah.

Oligocene volcanics consisting of rhyodacite, quartz latite, andesite, and air-fall tuff crop out in the northeast corner of the study area, and except for recent alluvium, form the youngest stratigraphic unit in the GRA.

3. STRUCTURAL GEOLOGY AND TECTONICS

The predominant structural feature in the study area is the Late Mesozoic-early Cenozoic thrust faulting of younger sediments over older. Rocks in the upper plate are all Middle Cambrian or younger and have undergone complex faulting. The stratified rocks in the lower plate are early Middle Cambrian or older and are only moderately faulted. The lower plate rocks have been slightly metamorphosed and are characterized by a weak schistocity. The Snake Range decollement separates the metamorphic rocks from the overlying non-metamorphic allochthonous sequence of Paleozoic rocks (Stewart, 1980). The para-autochthonous marbles in the Marble Canyon area have been locally intensely metamorphosed and deformed by folds and shears as described by Nelson (1969). This tectonite marble commonly occurs along the decollement (Coney, 1974).

Basin and Range high-angle normal, faulting which climaxed during the Late Miocene, was restricted to the eastern range front, the southwest corner of the GRA and the northwest tip of the range. As stated above the lower plate rocks, such as

those found in the northern Snake Range, have not been extensively faulted.

Excluding the eastern range front fault, the normal faults generally trend northwest for less than about five miles.

It should be noted that Hose and Blake (1976) attribute many of the high angle normal faults in the Snake Range to tectonic forces during the Late Mesozoic-Early Tertiary orogeny, however the normal faults in the northern Snake Range were not dated, precluding an exact dating of these structures.

4. PALEONTOLOGY

The Granite Spring GRA contains a number of different lithologies favorable for the occurrence of palentological resources, primarily Paleozoic marine strata. The following are those with known paleontological potential that occur within the GRA:

Pioche Shale (or equivalent)
Dunderberg Shale
Guilmette Formation
Eureka Quartzite
Ely Springs Dolomite
Simonson and Sevey Dolomites
Chainman Shale
Joanna Limestone
Ely Limestone

Fossils are rare in the Eureka Quartzite (Ordovician in this area), the Simonson, Sevey (Devonian) and Ely Springs (Ordovician-Silurian) dolomites and Chainman Shale (Mississippian) wherever they are encountered, and no localities from these units are known to occur within the GRA. The Dunderberg Shale has localized trilobite dominated faunas (Palmer, 1960), but no localities are definitely known from within the GRA. The Ely Limestone is discontinuously fossiliferous wherever encountered, and scattered brachiopod fossils have been collected in float from the extreme northern part of the area (Firby, field investigations).

Devonian and Mississippian rocks, primarily the Joanna Limestone and White Pine Shale (of Langenheim, 1962) contain abundant coral faunas outside the GRA, but occurrences of these faunas within the present study area have not been recorded due to the generally poor preservation of the fossil material. Newman (1980) utilizes conodonts from several formations, including the Chainman, to form the basis of biostratigraphic zonation in eastern Nevada and western Utah.

In addition to the marine fossils, two localities of Pleistocene nonmarine mollusca occur in the eastern part of the GRA in caves formed in Cambrian rocks. These localities are reocrded as the Smith Creek Cave site (NE 1/4 Sec. 16, T 17 N, R 70 E) and Council Hall Cave site (SE 1/4 Sec. 16, T 17 N, R 70 E) and contain the land snail Oreohelix nevadensis (Firby, 1977). These same sites also are noted archaeological localities.

5. HISTORICAL GEOLOGY

During the Paleozoic, marine sediments, predominantly carbonates, were deposited throughout the area. Two major tectonic events affected the region surrounding the GRA. Thrusting, high-angle faulting, and intrusive activity occurred sometime during the Late Cretaceous and continued to Early Tertiary time. Volcanism occurred in the northern part of the area towards the end of the Cretaceous-Early Tertiary orogeny and before Basin and Range faulting.

Basin and Range tectonism, responsible for much of the regional present-day topography of elongate fault block mountain ranges and flat bottomed valleys, began sometime during the mid-Tertiary and climaxed near the end of the Miocene.

III. ENERGY AND MINERAL RESOURCES

A. METALLIC MINERAL RESOURCES

1. Known Mineral Deposits

There are two known metallic mineral deposits in the GRA, both of which are outside the WSA. They are shown on the metallic Land Classification and Mineral Occurrence Map.

The White Cloud district is at the north end of the Snake Range in T 19 N, R 68 E. The Lead King mine is reported to have produced some lead, minor zinc and silver, and a trace of gold. Total value of production between 1949 and 1952 was on the order of $4,400. A visit to this site in 1979 by by Terra Data during the Schell Creek Mineral Resource Inventory indicated that massive bull quartz veins striking north in carbonates had been explored, but the Lead King mine location could not be verified.

The other reported production in the GRA came from the Silver Peak mine in Sec. 20, T 17 N, R 69 E, and included mostly lead with some silver and a trace of gold. The lead-silver ore bodies are replacement deposits in marble of the Pole Canyon Limestone where it is in fault contact with the underlying quartzite of the Pioche Formation (Smith, 1976).

2. Known Prospects, Mineral Occurrences and Mineralized Areas

The Grand View tungsten prospect is located in the vicinity of Sec. 11, T 17 N, R 68 E. Here coarse-grained scheelite is reported to be present in three feet of silicified limestone bordering a six-inch streak of galena-bearing quartz and calcite (Smith, 1976).

Some old workings were found in Sec. 26, T 17 N, R 70 E in the extreme southeast corner of the GRA during Terra Data's investigation in 1979. Numerous calcite veins with quartz are present in limestones with possible scheelite but this was not confirmed. Another adit was found, during this same inventory, in Sec. 21 of T 19 N, R 69 E, again in limestone and following a narrow quartz vein trending east-west. On the west flank of the Snake Range in the vicinity of Sec. 27, T 17 N, R 68 E there are several prospect pits in shale. These appear to be assessment work on old claims, but nothing additional is known about these prospects.

3. Mining Claims

The Bobcat group of lode mining claims is located in the area of the White Cloud district in the northwestern part of the GRA. Another group of lode claims called the Magnitude group is located in the vicinity of Sec. 10, T 17 N, R 70 E, but these are for an unknown commodity.

4. Mineral Deposit Types

The lead-silver deposits appear to be small replacement deposits along favorable structures in limestones. The potential scheelite is in limestones also, and along favorable structures for fluid migration. The scheelite is probably associated spacially with some intrusive activity in the area.

5. Mineral Economics

The small, narrow veins or replacement deposits in the GRA are probably not economically favorable targets at the present time because of the high cost of underground mining. Larger and more continuous deposits may be exploitable however, if they were to be found in the area.

The major uses of silver are in photographic film, sterlingware, and increasingly in electrical contacts and conductors. It is also widely used for storage of wealth in the form of jewelry, "coins" or bullion. Like gold it is commonly measured in troy ounces, which weigh 31.1 grand grams, twelve of which make one troy pound. World production is about 350 million ounces per year, of which the United States produces about one-tenth, while it uses more than one-third of world production. About two-thirds of all silver is produced as a by-product in the mining of other metals, so the supply cannot readily adjust to demand. It is a strategic metal. Demand is expected to increase in the next decades because of growing industrial use. At the end of 1982 the price of silver was $11.70 per ounce.

The largest use for lead is in electrical storage batteries, the second being a gasoline antiknock additive. It has many other uses, however, including radiation shielding, solders, numerous chemical applications, and in construction. About four million metric tons of lead are produced in the world annually. The United States produces about half a million tons per year, and recovers about the same amount from scrap -- much of it through the recycling of old batteries. It imports about one-quarter of a million tons. Lead is classified as a strategic mineral. Demand is projected to increase somewhat in the next couple of decades, but environmental concerns will

limit the increase. The United States has large ore reserves that are expected to last well beyond the end of this century at current production rates even without major new discoveries. At the end of 1982 the price was about 22 cents per pound.

The major uses of zine are in galvanizing, brass and bronze products, castings, rolled zinc and in pigments or other chemicals. About six million metric tons are produced annually, with the United States producing somewhat less than a quarter of a million tons. Domestic production has decreased dramatically over the past five years, largely as the result of closing down of most zinc smelters because of environmental problems. Imports into the United States are about one million tons per year, and zinc is listed as a strategic and critical metal. Both world-wide and domestic consumption are expected to increase at a moderate rate over the next twenty years. At the end of 1982 the price of zinc was about 38 cents per pound.

More than half of all tungsten used is in the form of tungsten carbide, a hard and durable material used in cutting tools, wear-resistant surfaces and hard-faced welding rods. Lesser quantities are used in alloy steels, in light bulb filaments, and in chemicals. World production of tungsten is nearly 100 million pounds annyually, of which the United States produces somewhat more than six million pounds, while using more than 23 million pounds. The shortfall is imported from Canada, Bolivia, Thailand and Mainland China, as well as other countries. Tungsten is a strategic and critical metal. United States demand is projected to about double by the year 2000, and most of the additional supply will probably be imported, because large reserves are in countries in which profitability is not a factor -- they need foreign exchange, and therefore sell at a price that few domestic mines can match. Tungsten prices F.O.B. mine are quoted for "short ton units", which are the equivalent of 20 pounds of contained tungsten. At the end of 1982 the price of tungsten was about $80 per short ton unit.

B. NONMETALLIC MINERAL RESOURCES

1. Known Mineral Deposits

The only reported nonmetallic mineral deposit in the GRA is marble, which is found in a wide area both to the north and south of Marble Canyon in the east central portion of the GRA. Much of this marble is also found in the WSA. It is reported by Smith (1976) that small quantities of marble were mined from this deposit and used for headstones at Garrison, Utah. He also states, however, that the marble is of poor quality and tends to slake and

weather rapidly. Terra Data on their visit to the area in 1979 indicates also that the quality of the marble is not exceptional, but that it could be utilized as a building stone, providing it could overcome some definite market disadvantages.

2. Mining Claims, Leases and Material Sites

Parts of at least 15 square miles of the marbleized limestone outcrop area partially in the north-central portion of the WSA has been staked for placer claims by Western Marble Inc. in the late 1960s and early 1970s and their assessment work appears to have been kept current. Perhaps as many as one-third to one-half of these claims lie within the WSA. There are no other claims shown active by BLM in the WSA.

There are no known material sites in the WSA, but the abundance of alluvium derived from the nearby competent carbonate units would indicate that a high quality aggregate is probably present.

3. Known Prospects, Mineral Occurrences and Mineralized Areas

There are a few prospects in Marble Canyon along the north boundary of the WSA in connection with the above described marble deposit.

4. Mineral Deposit Types

The marble is a weakly (and unevenly) regionally metamorphosed limestone.

5. Mineral Economics

The quality of the marble does not appear to make it likely to be used extensively for decorative rock or headstone purposes. The accessibility and the distance to the nearest substantial market probably also precludes any substantial production potential. Some minor production for nearby uses will probably limit the material for sporadic use only. The marble is not of exceptional quality, and similar marble can be found closer to the potential major markets. Also the cost of a quarry operation for marble these days is very expensive, hence marble is not being used as a building stone to the same magnitude it used to be.

The most common use of sand and gravel is as "aggregate" -- as part of a mixture with cement to form concrete. The second largest use is as road base, or fill. About 97

percent of all sand and gravel used in the United States is in these applications in the construction industry. The remaining three percent is used for glassmaking, foundry sands, abrasives, filters and similar applications. The United States uses nearly one billion tons of sand and gravel annually, all of it produced domestically except for a very small tonnage of sand that is imported for highly specialized uses. Since construction is by far the greatest user of sand and gravel, the largest production is near sites of intensive construction, usually metropolitan areas. Since sand and gravel are extremely common nearly everywhere, the price is generally very low and mines are very close to the point of consumption -- within a few miles as a rule. However, for some applications such as high-quality concrete there are quite high specifications for sand and gravel, and acceptable material must be hauled twenty miles and more. Demand for sand and gravel fluctuates with activity in the construction industry, and is relatively low during the recession of the early 1980s. Demand is expected to increase by about one third by the year 2000. In the early 1980s the price of sand and gravel F.O.B. plant average about $2.50 per ton, but varied widely depending upon quality and to some extent upon location.

C. ENERGY RESOURCES

Uranium and Thorium Resources

1. Known Mineral Deposits

   There are no known uranium or thorium deposits in the WSA or GRA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

   There are no known uranium or thorium occurrences in the WSA or GRA.

3. Mining Claims

   There are no known uranium or thorium claims or leases in the WSA or GRA.

4. Mineral Deposit Types

A discussion of deposit types is not possible due to a lack of known uranium or thorium occurrences.

5. Mineral Economics

Uranium and thorium are probably of little economic value in the GRA due to the lack of occurrences of these elements.

Uranium in its enriched form is used primarily as fuel for nuclear reactors, with lesser amounts being used in the manufacture of atomic weapons and materials which are used for medical radiation treatments. Annual western world production of uranium concentrates totaled approximately 57,000 tons in 1981, and the United States was responsible for about 30 percent of this total, making the United States the largest single producer of uranium (American Bureau of Metal Statistics, 1982). The United States ranks second behind Australia in uranium resources based on a production cost of $25/pound or less. United States uranium demand is growing at a much slower rate than was forecast in the late 1970s, because the number of new reactors scheduled for construction has declined sharply since the accident at the Three Mile Island Nuclear Plant in March, 1979. Current and future supplies were seen to exceed future demand by a significant margin and spot prices of uranium fell from $40/pound to 425/pound from January, 1980 to January, 1981 (Mining Journal, July 24, 1981). At present the outlook for the United States uranium industry is bleak. Low prices and overproduction in the industry have resulted in the closures of numerous uranium mines and mills, and reduced production at properties which have remained in operation. The price of uranium at the end of 1982 was $19.75/pound of concentrate.

Oil and Gas Resources

1. Known Oil and Gas Deposits

There are no known oil and gas deposits in the GRA.

2. Known Prospects, Oil and Gas Occurrences, and Petroliferous Areas

There are no known oil seeps in the GRA or bordering areas, although Dome Petroleum drilled Bastian Creek No. 1 (#1 on Oil and Gas Occurrence and Land Classification Map) to 4,761 feet in 1978 and Yelland No. 1 (#2) to 6,555 feet in 1980 in Spring Valley across the range from the GRA.

3. Oil and Gas Leases

There are about five sections of land under Federal lease in the WSA and over 40 more in the remainder of the GRA.

4. Oil and Gas Deposit Types

Oil deposits that have been found and developed, and those that are being explored for in the Basin and Range to date, have been limited to the Upper Paleozoic section of the miogeosyncline and the Tertiary section of the intermontane basins. The source rocks are assumed to be in Paleozoic horizons, such as the Mississippian Chainman Shale, and perhaps also the Tertiary section.

The reservoirs at the Trap Spring and Eagle Springs oil fields in Railroad Valley are the Oligocene Garrett Ranch volcanics or equivalent, which produce from fracture porosity; or the Eocene Sheep Pass Formation, a freshwater limestone. Minor production has been recorded from the Ely(?) Formation of Pennsylvanian age at Eagle Springs. It may be that production also comes from other units in the Tertiary or Paleozoic sections in the Blackburn oil field in Pine Valley or the Currant and Bacon Flat oil fields in Railroad Valley.

5. Oil and Gas Economics

The low level of production from Nevada Basin and Range oil fields, which are remote from existing pipelines, existing refineries and consuming areas, necessitates the trucking of the crude oil to existing refineries in Utah, California and Nevada. Since the discovery of oil in Nevada in 1953, the level of production has fluxuated. Factors which have affected the production from individual wells are: reservoir and oil characteristics; Federal regulations productivity; environmental constraints; willingness or ability of a refiner to take certain types of oil; and of course, the price to the producer, which is tied to regional, national and international prices.

Geothermal Resources

1. Known Geothermal Deposits

There are no known geothermal deposits in the GRA.

2. Known Prospects, Geothermal Occurrences, and Geothermal Areas

There are no known prospects, occurrences or thermal areas in the GRA or immediate vicinity.

3. Geothermal Leases

There are no recorded Federal geothermal leases in the GRA or vicinity.

4. Geothermal Deposit Types

Geothermal resources are hot water and/or steam which occurs in subsurface reservoirs or at the surface as springs. The temperature of a resource may be about 70°F (or just above average ambient air temperature) to well above 400°F in the Basin and Range Province.

The reservoirs may be individual faults, intricate fault-fracture systems, or rock units having intergranular permeability -- or a combination of these. Deep-seated normal faults are believed to be the main conduits for the thermal waters rising from thousands of feet below in the earth's crust.

The higher temperature and larger capacity resources in the Basin and Range are generally hydrothermal convective systems. The lower temperature reservoirs may be individual faults bearing thermal water or lower pressured, permeable rock units fed by faults or fault systmes. Reservoirs are present from the surface to over 10,000 feet in depth.

5. Geothermal Economics

Geothermal resources are utilized in the form of hot water or steam normally captured by means of drilling wells to a depth of a few feet to over 10,000 feet in depth. The fluid temperature, sustained flow rate and water chemistry characteristics of a geothermal reservoir determine the depth to which it will be economically feasible to drill and develop each site.

Higher temperature resources (above 350°F) are currently being used to generate electrical power in Utah and California, and in a number of foreign countries. As fuel costs rise and technology improves, the lower temperature limit for power will decrease appreciably -- especially for remote sites.

All thermal waters can be beneficially used in some way, including fish farming (68°F), warm water for year around mining in cold climates (86°F), residential space heating (122°F), greenhouses by space heating (176°F), drying of vegetables (212°F), extraction of salts by evaporation and crystallization (266°F), and drying of diatomaceous earth (338°F).

Unlike most mineral commodities remoteness of resource location is not a drawback. Domestic and commercial use of natural thermal springs and shallow wells in the Basin and Range Province is an historical fact for over 100 years.

Development and maintenance of a resource for beneficial use may mean no dollars or hundreds of millions of dollars, depending on the resource characteristics, the end use and the intensity or level of use.

D. OTHER GEOLOGICAL RESOURCES

According to McLane (1974) there are several caves in the GRA. There are a cluster of five caves in the Smith Creek area along the southern border of the WSA, two other caves, Yorks and Rockslide, just south of Smith Creek. All these caves are in T 17 N, R 70 E. There are no other unique or unusual geologic resources known in the GRA.

E. STRATEGIC AND CRITICAL MINERALS AND METALS

A list of strategic and critical minerals and metals provided by the BLM was used as a guideline for the discussion of strategic and critical materials in this report.

The Stockpile Report to the Congress, October 1981 - March 1982, states that the term "strategic and critical materials" refers to materials that would be needed to supply the industrial, military and essential civilian needs of the United States during a national emergency and are not found or produced in the United States in sufficient quantities to meet such need. The report does not define a distinction between strategic and critical minerals.

Lead and minor silver and zinc have been produced on a very limited scale from two properties in the GRA (but not from within the WSA), the Lead King mine and the Silver Peak mine. Substantial future production from either of these deposits seems unlikely based on the available information.

IV. LAND CLASSIFICATION FOR G-E-M ROURCES POTENTIAL

The geologic maps which cover the WSA include Hose and Blake (1976) and Howard (1978), both at a scale of 1:250,000 and both essentially the same for this WSA. The scale of these maps is too small to show much detail, and areas of alteration, if present, are not shown. Smith, 1976, has the most comprehensive data on mineralization in the GRA, but it is still minimal. Overall the quantity of geologic data available is somewhat lacking in detail, but the quality of what is available is believed to be good.

The quantity of data concerning mineral resources is limited, in part at least because there has been very little mineral resources identified in the area, but the quality is considered relatively good. The overall level of confidence in all available information is good.

Land classification areas are numbered starting with the number 1 in each category of resources. Metallic mineral land classification areas have the prefix M, e.g. M1-4D. Uranium and thorium areas have the prefix U. Nonmetallic mineral areas have the prefix N. Oil and gas areas have the prefix OG. Geothermal areas have the prefix G. Sodium and potassium areas have the prefix S. The saleable resources are classified under the nonmetallic mineral resource section. Both the Classification Scheme, numbers 1 through 4, and the Level of Confidence Scheme, letters A, B, C, and D, as supplied by the BLM are included as attachments to this report. These schemes were used as strict guidelines in developing the mineral classification areas used in this report.

Land classifications have been made here only for the areas that encompass segments of the WSA. Where data outside a WSA has been used in establishing a classification area within a WSA, then at least a part of the surrounding area may also be included for clarification. The classified areas are shown on the 1:250,000 mylars or the prints of those that accompany each copy of this report.

In connection with nonmetallic mineral classification, it should be noted that in all instances areas mapped as alluvium are classified as having moderate favorability for sand and gravel, with moderate confidence, since alluvium is by definition sand and gravel. All areas mapped as principally limestone or dolomite have a similar classification since these rocks are usable for cement or lime production. All areas mapped as other rock, if they do not have specific reason for a different classification, are classified as having low favorability with low confidence for nonmetallic mineral potential, since any mineral material can at least be used in construction applications.

1. LOCATABLE RESOURCES

a. Metallic Minerals

WSA NV 040-086

M1-2B. This land classification area of low favorability with a low confidence level includes all the bedrock in the WSA, which is all or predominantly limestone. According to the White Pine County geologic map by Hose and Blake (1976), the area encompassed by the WSA is composed of various Paleozoic limestones. A small area of Pogonip Group and Eureka Quartzite has been mapped in the WSA, but since it is not known whether the quartzite is present, and since it is such a small area anyway, this unit was not given a separate classification. Also, there is a very small area, several acres, of Tertiary volcanics included also in the very eastern part of the WSA.

The classification 2B is designated because similar limestones outside the WSA, but within the GRA, are host to minor lead-silver replacement deposits and also contain minor quartz or calcite veins. Also there is scheelite in similar limestones both within and outside the GRA (but not in the WSA). Since there are abundant intrusive rocks in other parts of the Snake Range, including some within the GRA but outside the WSA, there is a possibility that there may be buried intrusives in the WSA with associated tungsten mineralization.

M2-2A. The classification area of low favorability with a very low confidence level includes all the alluvium in the WSA. The classification is 2A because even though no metallic mineral resources are believed or expected to occur in the alluvium, the nature of the bedrock beneath the alluvium is unknown. Since the adjacent bedrock has a low favorability it stands to reason that the same units buried beneath alluvium would also have a low favorability, but there is no evidence to support this, hence the A confidence level.

b. Uranium and Thorium

WSA NV 040-086

U1-2B. This land classification covers most of the GRA and all of the WSA except its eastern margin. The majority of the area is covered by Lower Paleozoic carbonates, shales and quartzites, with minor amounts of Tertiary volcanic flows and tuffs in the northern part of the GRA and small Cretaceous-Tertiary quartz monzonite intrusions southwest of the WSA. The area has low favorability at a low confidence level for uranium in vein or fracture-filling deposits associated with intrusion of

quartz monzonite into the Paleozoic carbonates. Tertiary volcanics in the northern part of the GRA are another possible source of uranium which could be mobilized by ground water and deposited in fractured sediments or other volcanics.

The area appears to have no thorium source rocks and therefore has very low favorability for thorium at a very low level of confidence.

U2-1A. This classification covers the eastern margin of the WSA, the eastern and western margins and three small areas in the northern part of the GRA. The areas are covered by Quarternary alluvium, and all except one appear to have no favorability for epigenetic sandstone uranium deposits at a very low level of confidence. The small north-south-trending area in the north-central part of the GRA occurs adjacent to Tertiary volcanics, which could possibly be a uranium source for this type of deposit, but the remainder of the areas occur adjacent to Paleozoic carbonates which are probably a poor source for uranium.

The area has very low favorability for thorium, at a very low confidence level, due to the apparent lack of source rocks.

c. Nonmetallic Minerals

WSA NV 040-086

N1-4D. This classification area of high favorability with a high confidence level includes the Cambrian marble in and near Marble Canyon which has been mined for building stone or monuments on a limited basis and which is covered with placer claims. The material in this area could be used as building stone or possibly in cement or lime manufacture.

N2-3C. This classification area of moderate favorability with a moderate confidence level includes the remainder of the Cambrian limestone in the WSA which is not covered by mining claims. According to the geologic map of White Pine County it has been metamorphosed, thereby possibly forming marble similar to that in classification area N1-4D. It could be utilized in the same way for building stone or possibly in cement or lime.

N3-3C. This classification area of moderate favorability with a moderate confidence level includes the remaining bedrock units in the WSA which have not been metamorphosed. Minor volcanic rocks and possibly some quartzite may be included. The limestones could possibly be utilized in cement or lime manufacture depending on their chemical properties.

N4-3C. This classification area of moderate favorability with a moderate confidence level includes all the alluvium in the WSA. The material could probably be utilized for sand and gravel for local construction material applications. The alluvium has been derived from nearby competent carbonate units and therefore the quality of potential aggregate sources may be high.

2. LEASABLE RESOURCES

a. Oil and Gas

WSA NV 040-086

OG1-2A. This classification bounds that portion of the WSA that is underlain by Snake Valley alluvium. There is a possibility that range front faults of several thousand feet displacement could allow for a favorable section to drill in this area. Exploration wells are occasionally located very close to the mountains in this physiographic province. The objective would be Paleozoic and Tertiary strata known to be source/reservoir rocks in Nevada. Similar strata exist in the Snake Range and nearby mountains and valleys.

OG2-1A. That part of the WSA which is underlain by the potential source and reservoir section of the Paleozoics in outcrop is not believed to have potential. The Federal leasing pattern generally verifies this.

b. Geothermal

WSA NV 040-086

G1-2A. Although there are no known geothermal occurrences in the immediate area, deep-seated, range front faults, similar to many which are conduits for rising thermal waters in many other parts of the Basin and Range Province, probably lie hidden beneath the valley alluvium. Shallow drilling in these areas may reveal thermal waters that could be developed.

G2-1A. This classification includes that portion of the WSA underlying the main mountain mass. It is unlikely, considering the paucity of geothermal resources in the area, that they will be found here.

c. Sodium and Potassium

S1-1D. There are no sodium or potassium resources known or suspected to exist in the WSA. There is no classification map for this commodity.

3. SALEABLE RESOURCES

Saleable resources, sand and gravel, have been discussed above under nonmetallic resources and include classification area N4-3C.

V. RECOMMENDATIONS FOR ADDITIONAL WORK

1. The area needs detailed mapping at a much larger scale than the 1:250,000 scale currently available. More detailed mapping and possibly sampling could further delineate the metallic mineral resource potential of the WSA. The owners of the placer claims could be contacted for their opinion on future market potential of the marble in the WSA.

2. There are 16 claims in T 17 N, R 70 E bordering the southern boundary of the WSA on Forest Service land. These claims are for an unknown commodity and are not associated with any known mineral occurrences. These claims should be further investigated in order to determine the commodity involved, and if there is any potential adjacent to these claims in the WSA.

VI. REFERENCES AND SELECTED BIBLIOGRAPHY

Adair, D. H., and Stringham, B. F., 1960, Intrusive igneous rocks of east-central Nevada, in Guidebook to the geology of east-central Nevada: Intermountain Assoc. Petroleum Geologists and Eastern Nevada Geol. Soc., 11th Ann. Field Conf., Salt Lake City, Utah, 1960, p. 229-231.

Bohannan, R. G., 1978, Preliminary geology map of Las Vegas 1° x 2° Quadrangle, Nevada, Arizona, and California: U. S. Geol. Survey Open File Report 78-670.

Collinson, J. W., Kendalland, C. G. C., and Marcantel, J. B., 1976, Permian-Triassic boundary in eastern Nevada and west-central Utah: Geol. Soc. America Bull. V. 87.

Coney, P. J., 1974, Structural analysis of the Snake Range "decollement", east-central Nevada: Geol. Soc. America Bull., v. 85, no. 6.

Firby, J. R., 1977, Gastropods from Smith Creek and Council Hall Caves and associated Lake Bonneville Terrace, White Pine County, Nevada: Nevada State Museum Anthro. Papers No. 17., P. 386-394.

Garside, L. J., and Schilling, J. H., 1979, Thermal waters of Nevada: Nevada Bur. of Mines and Geol. Bull. 91.

Hose, R. K., and Blake, M. C., Jr., 1969, Structural development of the eastern Great Basin during the Mesozoic [abs.]: Geol. Soc. America Abstracts with Program for 1969, pt. 5, p. 34.

Hose, R. K., and Blake, M. C., Jr., 1976, Geology and mineral resources of White Pine County, Nevada Part I - Geology: Nevada Bur. of Mines and Geol. Bull. 85.

Howard, E. L., ed., 1978, Geologic map of the eastern Great Basin, Nevada and Utah, Terra Scan Group Ltd.

Langenheim, R. L., Jr., 1960, Early and middle Mississippian stratigraphy of the Ely area (Nevada) in Guidebook to the geology of east-central Nevada: Intermountain Assoc. Petroleum Geologists and Eastern Nevada. Geol. Soc., 11th Ann. Field Conf., Salt Lake City, Utah, p 72-80.

Langenheim, R. L., Jr., and Larson, E. R., 1973, Correlation of Great Basin stratigraphic units: Nevada Bur. Mines and Geol. Bull. 72, p. 1-36.

Lee, D. E., Marvin, R. F., Stern, T. W., and Peterman, Z. E., 1970, Modification of K/Ar ages by Tertiary thrusting in the Snake Range, White Pine County, Nevada, in Geological Survey research, 1970: U. S. Geol. Survey Prof. Paper 700-D, p. D92-D102.

Lochman-Balk, C., 1956, The Cambrian of the Rocky Mountains and southern deserts of the United States and adjoining Sonoma Province, Mexico, in the Cambrian system, it's paleogeography and the problem of it's base: 20th International Geol. Cong., v. 2, pt. 2, p. 529-560.

Nevada Bureau of Mines and Geology, 1982, List of wells drilled for oil and gas, January 1977 through the present (November 8, 1982): Nevada Bureau of Mines and Geol. List L-4.

McLane, A. R., 1974, Bibliography of Nevada Caves.

Misch, Peter, 1960, Regional structural reconnaissance in central-northeast Nevada and some adjacent areas--observations and interpretations, in Guidebook to the geology of east-central Nevada: Intermountain Assoc. Petroleum Geologists and Eastern Nevada Geol. Soc., 11th Ann. Field Conf., Salt Lake City, Utah, 1960, p. 17-42.

Misch, P., and Hazzard, J. C., 1962, Stratigraphy and metamorphism of Late Precambrian rocks in central northeastern Nevada and adjacent Utah: American Assoc. Petroleum Geol. Bull., v. 46, p. 289-343.

Nelson, R. B., 1959, The stratigraphy and structure of the northernmost part of the northern Snake Range and Kern Mountains in eastern Nevada and the southern Deep Creek Range in western Utah: Ph.D. thesis, Washington Univ., Seattle.

Nelson, R. B., 1969, Relation and history of structures in a sedimentary succession with deeper metamorphic structures, eastern Great Basin: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 2, p. 307-339.

Newman, G. J., 1980, Conodonts and biostratigraphy of the Lower Mississippian in western Utah and eastern Nevada: Brigham Young Univ. Geol. Studies, v. 27, p. 103-121.

Nolan, T. B., 1943, The Basin and Range Province in Utah, Nevada and California: U. S. Geol. Survey Prof. Paper 197D, p. 141-146.

Nolan, T. B., Merriam, C. W., and Williams, J. S., 1956, The stratigraphic section in the vicinity of Eureka, Nevada: U. S. Geol. Survey Prof. Paper 276, p. 1-77.

Osmond, J. C., Jr., 1954, Dolomites in Silurian and Devonian of east-central Nevada: American Assoc. Petroleum Geologists Bull., v. 46, p. 2033-2056.

Palmer, A. R., 1960, Some aspects of the early Upper Cambrian stratigraphy of White Pine County, Nevada and vicinity, in Geology of east-central Nevada: Intermountain Assoc. Petroleum Geologists, 11th Ann. Field Conf., 1960 Guidebook, p. 53-58.

Rich, M., 1967, Donezella and Dvinella, widespread algae in Lower and Middle Pennsylvanian rocks in east-central Nevada and west-central Utah: Jour. Paleontology, v. 41, no. 4, p. 973-980.

Rigby, J. K., 1959, Some Ordovician sponge localities from western Utah and eastern Nevada [abs.]: Utah Acad. Science, Arts and Letters, Proc., v. 36, p. 192.

Robison, R. A., Lower and Middle Cambrian stratigraphy of the eastern Great Basin, in Geology of east-central Nevada: Intermountain Assoc. Petroleum Geologists and Eastern Nevada Geol. Soc., 11th Ann. Field Conf. Salt Lake City, Utah, p. 43-52.

Sando, W. J., 1980, The paleoecology of Mississippian corals in the western conterminous United States: Acta Paleontologica Polonica, v. 25, nos. 3 & 4, p. 619-631.

Sheehan, P. M., 1971, Silurian brachiopoda, community ecology, and stratigraphic geology in western Utah and eastern Nevada, with a section on Late Ordovician stratigraphy: Ph.D. Dissertation (unpubl.) Univ. Calif. Berkeley.

Smith, R. M., 1976, Geology and Mineral Resources of White Pine County, Nevada, Part II - Mineral Resources: Nevada Bureau of Mines and Geology, Bull. 85.

Steele, Grant, 1960, Pennsylvanian-Permian stratigraphy of east-central Nevada and adjacent Utah, in Guidebook to the geology of east-central Nevada: Intermountain Assoc. Petroleum Geologists and Eastern Nevada Geol. Soc., 11th Ann. Field Conf., Salt Lake City, Utah, 1960, p. 91-113.

Stewart, J. H., 1980, Geology of Nevada - a discussion to accompany the geologic map of Nevada: Nevada Bureau of Mines and Geol. Spec. Publ. No. 4, p. 1-136.

Stewart, J. H., and Carlson, J. E., 1978, Geologic map of Nevada: U. S. Geol. Survey in cooperation with Nevada Bur. of Mines and Geology.

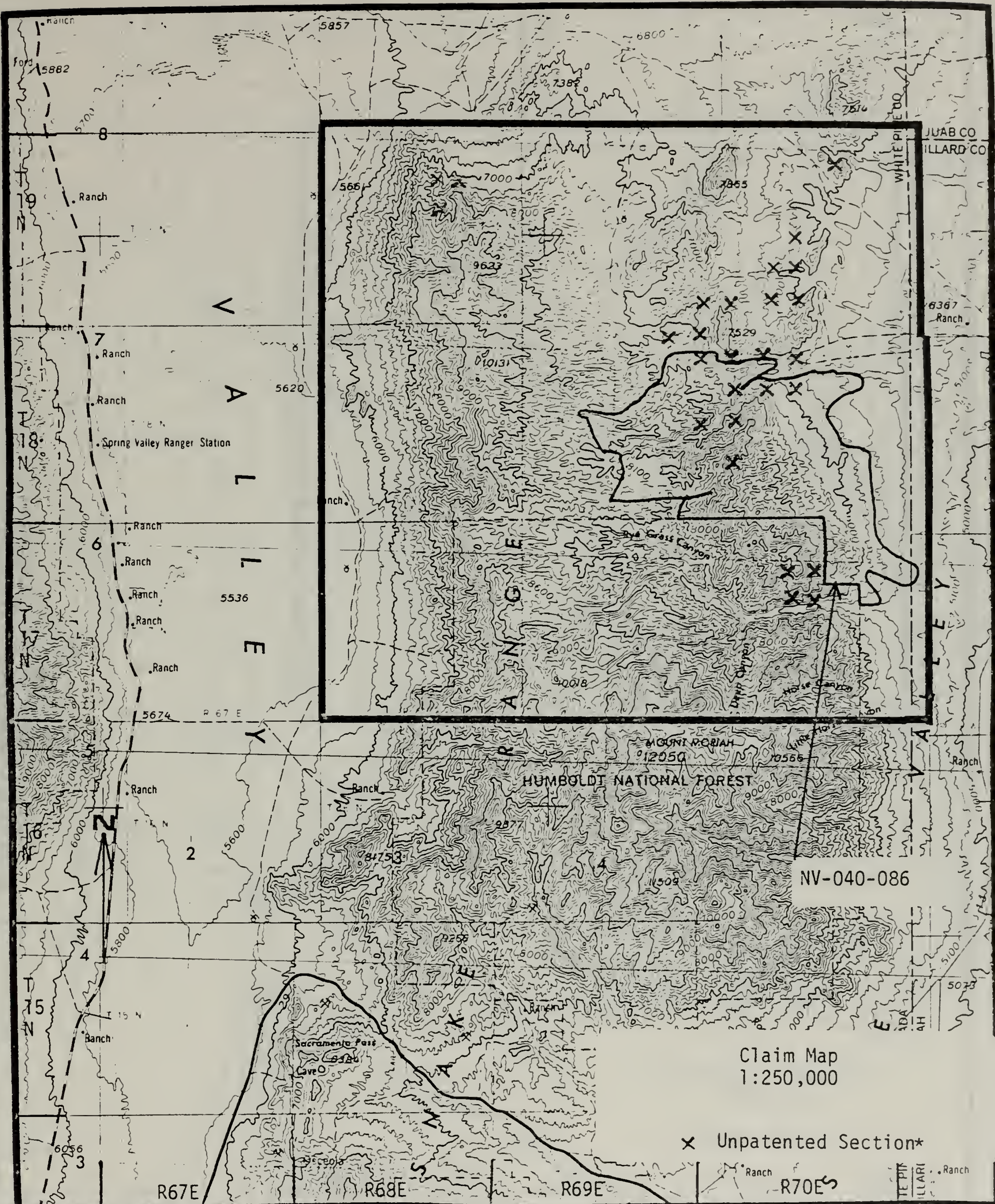
Terra Data, 1979, Schell Creek Mineral Resource Inventory; BLM Contract.

Tyson, M. C., 1980, Conodont biostratigraphy of the Mississippian Chainman Formation, western Millard County, Utah: Jour. Paleontology, v. 54, no. 6, p. 1232-1309.

Walcott, C. D., 1908, Cambrian sections of the Cordilleran area: Smithsonian Misc. Coll., v. 53, No. 1812, p. 166-230.

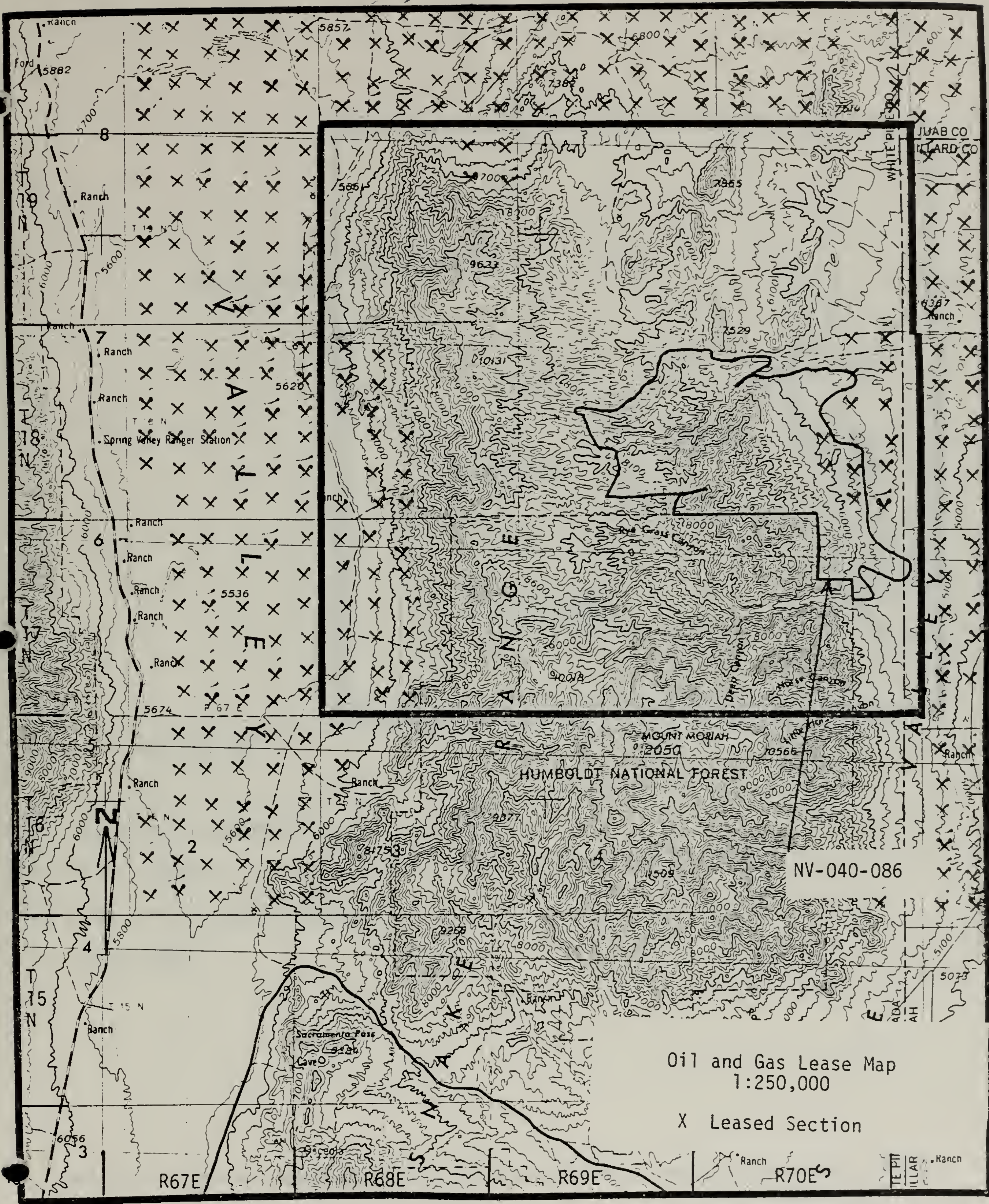
Wilson, E. C., 1963, The tabulate coral Multitecopora Yoh from the Chaetetes-Profusulinella faunizone in eastern Nevada: Jour. Paleontology, v. 37, no. 1, p. 157-163.

Younquist, W., 1949, The cephalopod fauna of the White Pine Shale of Nevada: Jour. Paleontology, v. 23, No. 3, pt. 1, p. 276-305. suppl., no. 6, p. 613-616.

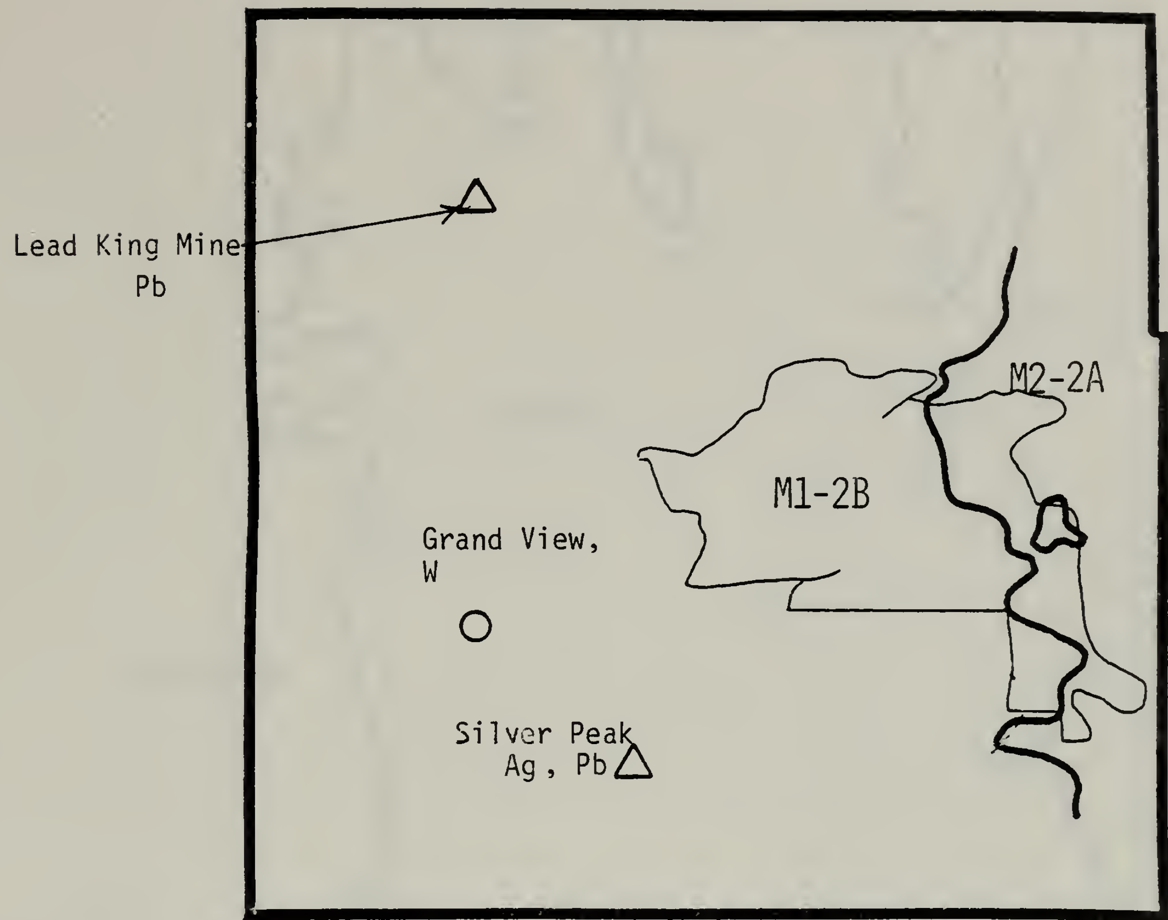


*X denote one or more claims per section

Granite Spring GRA NV-09



NV-040-086
Oil and Gas Lease Map
1:250,000
X Leased Section
HUMBOLDT NATIONAL FOREST
MOUNT MORIAH
Spring Valley Ranger Station
Rye Grass Canyon
Deep Canyon
Horse Canyon
Sacramento Pass
JUAB CO
R67E
R68E
R69E
R70E



EXPLANATION

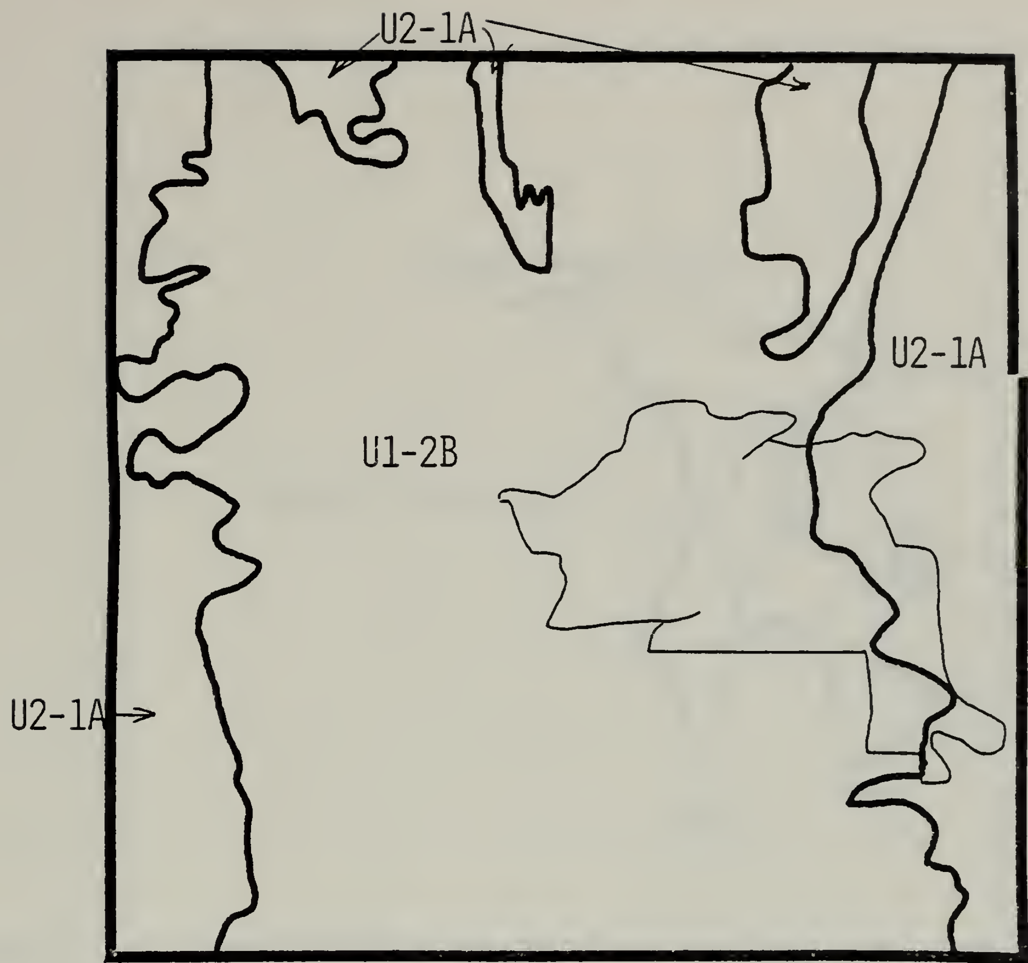
○ Occurrence, commodity

△ Mine, commodity

━ Land Classification Boundary

— WSA Boundary

Land Classification - Mineral Occurrence Map/Metallics Granite Spring GRA NV-09
Scale 1:250,000

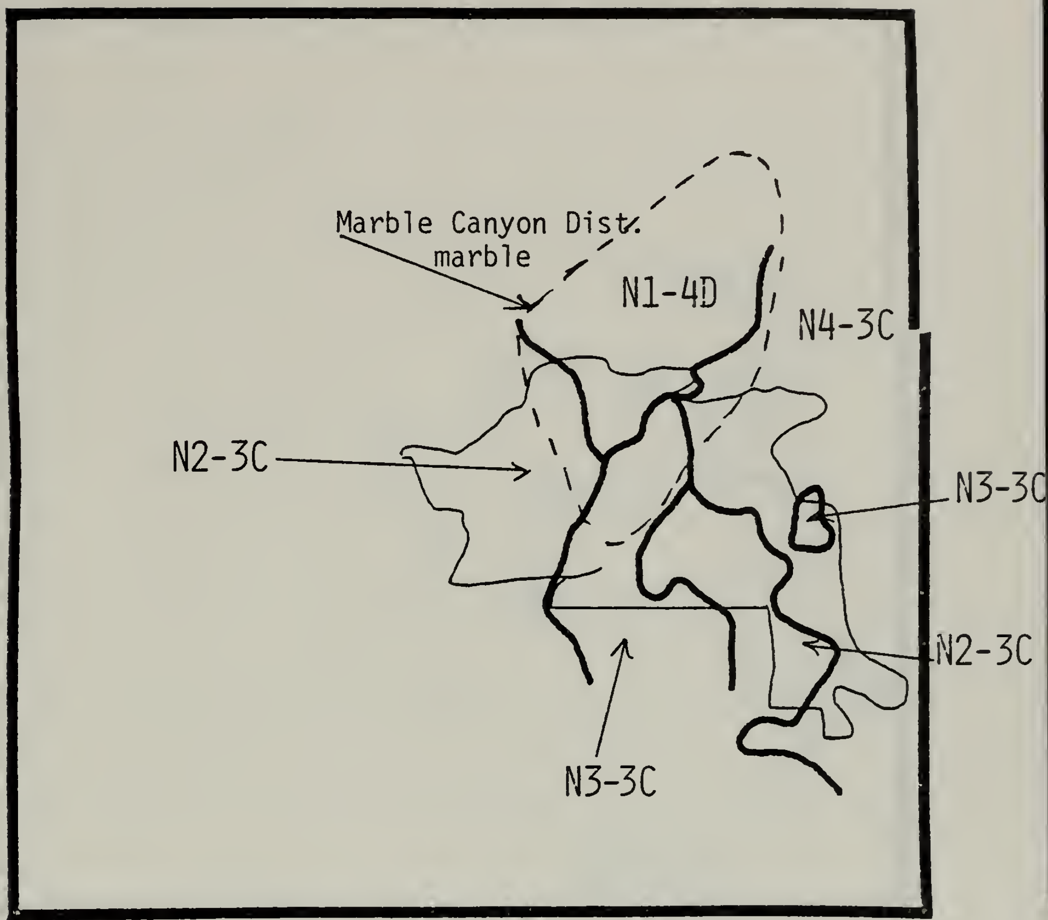


EXPLANATION

Land Classification Boundary

WSA Boundary

Land Classification - Mineral Occurrence Map/Uranium Granite Spring GRA NV-09
Scale 1:250,000



EXPLANATION

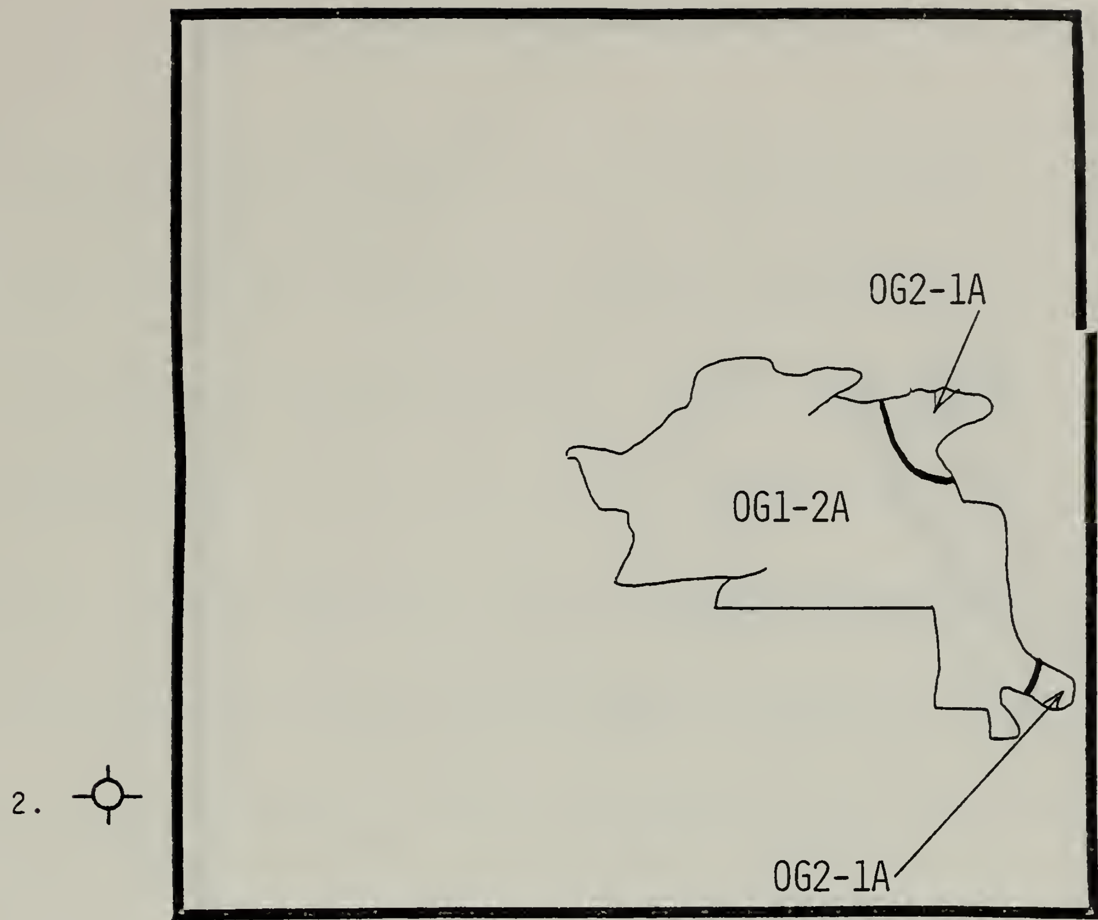
- - - Mining District, commodity

▬ Land Classification Boundary

— WSA Boundary

Land Classification - Mineral Occurrence Map/Nonmetallics

Granite Spring GRA NV-09
Scale 1:250,000



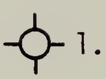
EXPLANATION

1. Reference location (see text)

Dry hole

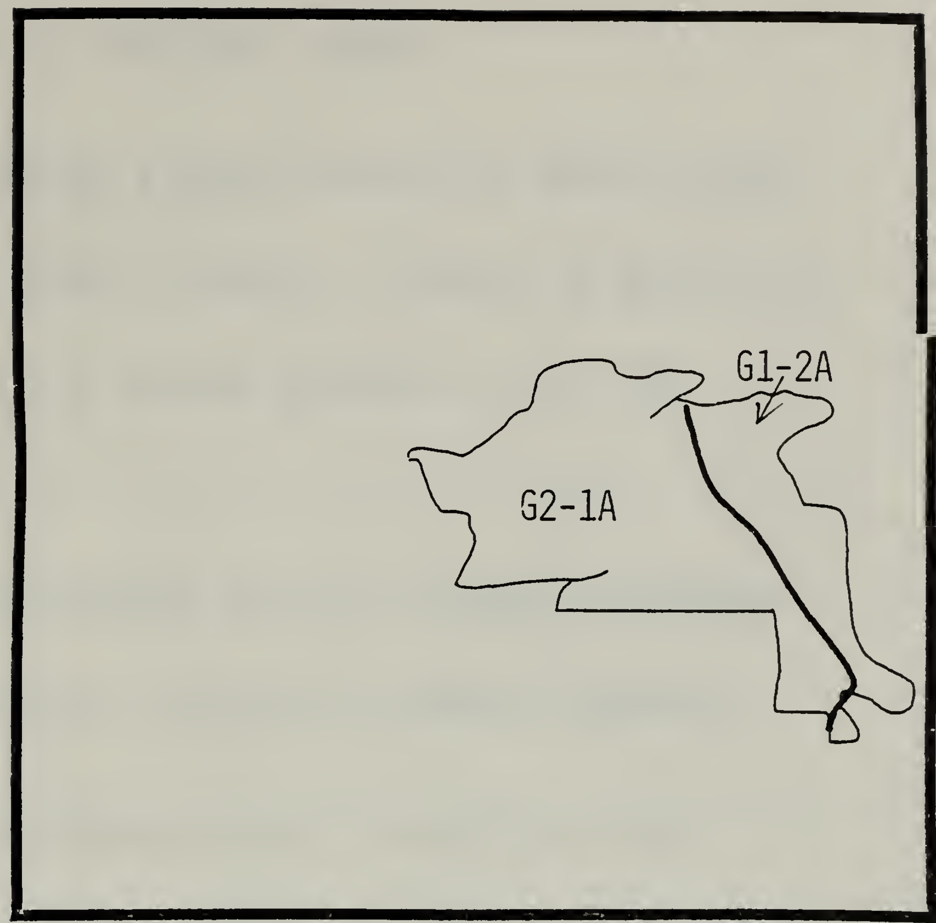
Land Classification Boundary

WSA Boundary



Land Classification - Mineral Occurrence Map/Oil & Gas

Granite Spring GRA NV-09
Scale 1:250,000



EXPLANATION

Land Classification Boundary

WSA Boundary

Granite Spring GRA NV-09

Land Classification - Mineral Occurrence Map/Geothermal

Scale 1:250,000

LEVEL OF CONFIDENCE SCHEME

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVELY MINIMAL TO SUPPORT TO REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

MAJOR STRATIGRAPHIC AND TIME DIVISIONS IN USE BY THE U.S. GEOLOGICAL SURVEY

Erathem or Era	System or Period	Series or Epoch	Estimated ages of time boundaries in millions of years
Cenozoic	Quaternary	Holocene	
		Pleistocene	2-3 [1]
	Tertiary	Pliocene	12 [1]
		Miocene	26 [2]
		Oligocene	37-38
		Eocene	53-54
		Paleocene	65
Mesozoic	Cretaceous [4]	Upper (Late) Lower (Early)	136
	Jurassic	Upper (Late) Middle (Middle) Lower (Early)	190-195
	Triassic	Upper (Late) Middle (Middle) Lower (Early)	225
Paleozoic	Permian [4]	Upper (Late) Lower (Early)	280
	Carboniferous Systems: Pennsylvanian [4]	Upper (Late) Middle (Middle) Lower (Early)	
	Carboniferous Systems: Mississippian [4]	Upper (Late) Lower (Early)	345
	Devonian	Upper (Late) Middle (Middle) Lower (Early)	395
	Silurian [4]	Upper (Late) Middle (Middle) Lower (Early)	430-440
	Ordovician [4]	Upper (Late) Middle (Middle) Lower (Early)	500
	Cambrian [4]	Upper (Late) Middle (Middle) Lower (Early)	570
Precambrian [4]		Informal subdivisions such as upper, middle, and lower, or upper and lower, or younger and older may be used locally.	3,600 + [3]

[1] Holmes, Arthur, 1965, Principles of physical geology: 2d ed., New York, Ronald Press, p. 360-361, for the Pleistocene and Pliocene; and Obradovich, J. D., 1965, Age of marine Pleistocene of California: Am. Assoc. Petroleum Geologists, v. 49, no. 7, p. 1087, for the Pleistocene of southern California.

[2] Geological Society of London, 1964, The Phanerozoic time-scale; a symposium: Geol. Soc. London, Quart. Jour., v. 120, supp., p. 260-262, for the Miocene through the Cambrian.

[3] Stern, T. W., written commun., 1968, for the Precambrian.

[4] Includes provincial series accepted for use in U.S. Geological Survey reports.

Terms designating time are in parentheses. Informal time terms early, middle, and late may be used for the eras, and for periods where there is no formal subdivision into Early, Middle, and Late, and for epochs. Informal rock terms lower, middle, and upper may be used where there is no formal subdivision of a system or of a series.

GEOLOGIC NAMES COMMITTEE, 1970